975,783

PATENT SPECIFICATION

DRAWINGS ATTACHED

975,783

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COMPLETE SPECIFICATION

Method of Making an Article of a Polymeric Resin having Co-ordinated Surface Relief and Colouring

We, UNITED STATES RUBBER COMPANY, of Rockefeller Centre, 1230 Avenue of the Americas, New York 20, State of New York, United States of America, a corporation organized and existing under the laws of the State of New Jersey, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a method of making plastic sheet material having coordinated relief and colour effects.

This invention consists in a method of making an article of a polymeric resin having coordinated surface relief and colouring; which method comprises applying a coloured material to a vacuum former having one or more depressions and/or apertures therein, the coloured material being adherent to the polymeric resin and strippable from the former and being applied to one or more surface areas of the former which do not constitute depressions, applying a sheet of the polymeric resin to the surface of the former, evacuating air from the space between the sheet and the former, releasing the vacuum, and stripping the formed sheet with the coloured material adhering thereto.

The invention will be described in detail with reference to the accompanying drawing, wherein:

Fig. 1 is a plan view of a plastic sheet having a relief design and coloured decorative pattern, applied in accordance with the method of the invention;

Fig. 2 is a sectional view of the plastic sheet, taken along line 2—2 of Fig. 1;

Fig. 3 is a plan view of a perforated metal forming plate used in the method;

Fig. 4 is a sectional view of the metal plate, taken along line 4—4 of Fig. 3;

Figs. 5 and 6 are similar views, showing successive resinour coatings applied to the upper surface of the metal plate;

Fig. 7 is a sectional view of the plastic sheet, prior to forming, clamping in a supporting frame;

Fig. 8 is a sectional view of an assembly of clamped plastic sheet and resin-coated forming plate disposed on a vacuum applying table, prior to application of vacuum; and

Fig. 9 is a similar view, after application of vacuum.

The invention involves vacuum forming a thermoplastic sheet at elevated temperature against a grid-like or similar forming member to provide a desired relief configuration, such grid-like forming member having been provided previously with a coating of colored material, on the surface adjacent to the plastic sheet, which is adherent to the plastic sheet but strippable from the forming member. The plastic sheet is cooled while still under the influence of vacuum in contact with the forming member, to a temperature at which it is form sustaining; the vacuum is then broken and the formed sheet is removed with the colored coating adhering to the recessed surface of the grid-like pattern imparted by the forming member. The colored coating thus transfers from the forming member to the plastic sheet in the form of a colored pattern or design, corresponding to the exact design of the forming member, such colored pattern being in exact registry with

[Price 4s

the relief design imparted simultaneously to the plastic sheet.

The plastic materials to which the invention applies may be either flexible or rigid sheets, and may be of any desired thickness suitable for vacuum forming. Thus, sheets thin enough to be classified as films may be used, as well as relatively heavy sheets 1/2 inch or more in thickness. Such thermoplastic sheet materials as vinyl plastics including not only polyvinyl chloride but mixtures of polyvinyl chloride with other polymers and copolymers of vinyl chloride with other monomers such as vinyl acetate, diethyl maleate, etc.; acrylic plastics such as methyl methacrylate, with or without admixture of other polymers, or copolymers of acrylic monomers with other monomers such as styrene; polystyrene; polyethylene; polypropylene; and the like, may be used Preferred vacuum formable thermoplastic materials are the gum plastics, such as are obtained by mixing resins (e.g., styrene-acrylonitrile resin, with or without polyvinyl chloride resin) and rubbers (e.g. butadiene-acrylonitrile rubber) or by grafting resin forming monomers (e.g., styrene, acrylonitrile methyl methacrylate or the like) on rubbers (e.g. polybutadiene, butadiene-styrene copolymer, or the like). Such plastics are frequently of the type known as ABS plastics, meaning that they are comprised of acrylonitrile, butadiene and styrene; these are especially suitable in admixture with a major proportion of polyvinyl chloride resin. The plastics used in the invention are referred to as thermoplastic, in the sense that they are capable, when heated, of becoming soft and formable enough to be shaped by vacuum (or equivalent differential pressure) but this is not intended to exclude the possibility that the composition may include polymers, such as rubbers, which are capable of being vulcanized once the heat forming has been accomplished. Thus, unvulcanized rubber (which is thermoplastic) may be vacuum formed in accordance with the invention and may thereafter be vulcanized to an essentially non-thermoplastic state. The plastic material employed in the invention may be a blown or expanded material, such as sponge rubber (useful, for example, as multicolored rug underlay having a waffle configuration or similar relief configuration) or blown vinyl film or sheet as described in U.S. patent 2,964,799, Roggi et al., Dec. 20, 1960. In fact, in the case of material of relatively heavy gauge such as sponge rubber rug underlay the requirement for application of vacuum during the shaping is minimized, since the material frequently is heavy enough to sink into conformity with the shaping grid member by gravity when sufficiently softened by heat and/or the action of the blowing agent in the sponge rubber formulation may cause the composition to conform to the shaping grid member especially when confined in a sponge press or similar device conventionally used in making rug underlay. If desired, the plastic sheet or film material employed may be supported, that is, it may have a flexible backing, such as a textile (for example, a solid vinyl coated fabric or expanded vinyl coated fabric as in Roggi et al, or burlap-backed sponge rubber rug underlay, may be used), paper, or other backing that does not interfere with the forming operation. Particularly preferred plastics are transparent or translucent compositions, such as those of U. S. Patent 3,018,268, Daly, Jan. 23, 1962. These are especially useful in making signs and displays, decorative or luminous panels or partitions, or other sheet articles, which give one color effect when viewed from one side and a different color effect when viewed from the other side, as will be described in more detail below.

The shaping grid or similar forming member relied upon to impart the desired relief configuration to the heated plastic sheet in the method of the invention may be made of metal or any other suitable material, and is usually a flat grid or screen, such as for example the sheet metal grills used in making radiator covers. Thus, there may be used a flat metal plate or sheet covered with openings in the form of various shapes (e.g. squares, diamonds, circles, etc., or combinations thereof) designed to produce the desired pattern. The pattern may be geometric and symmetrical if desired, or it may be random, unsymmetrical or free form. The openings may be in the form of letters or other figures, as for example when the article is to be used as a sign. The shaping grid need not be used in the flat, but may if desired be curved and mounted for example on a rotary drum equipped for vacuum, especially when the process is carried out continuously on a running length of plastic material. The openings in the grid serve to give access of the vacuum to the heated plastic sheet, thus drawing or sucking the sheet into such openings and thereby imparting to the sheet a relief configuration corresponding to the openings in the sheet. It is not essential that the forming member be a completely perforated sheet, that is, the forming member can be a plate or drum having an arrangement of cavities or depressions engraved or otherwise provided in its surface in accordance with the desired relief design, lettering, figures or the like, but each such cavity or depression must contain at least one passageway or opening leading to the source of vacuum so that the plastic can be drawn into the cavity or depression to produce the desired relief shape. It will be apparent that not all of the cavities of the forming member need be of the same depth, nor need the entire outer surface of the forming member lie in a single plane.

In accordance with the invention, the surface of the forming member, prior to the vacuum forming operation, is provided with a transferable colored material, that is, a colored coating composition or the like which is more strongly adherent to the heated plastic material than it is to the surface of the forming member. Especially suitable for this purpose are colored thermoplastic film-forming resinous compositions, which may be based on the same plastic as the plastic sheet to be formed, or may be based on a different resin. Suitable resins for use in the colored composition include those mentioned above in connection with the description of the formable plastic sheet material, and there may be mentioned again especially the acrylic resins (e.g. methyl methacrylate and copolymers thereof), vinyl chloride homopolymer and copolymers, and blends of these and other thermoplastic resins. The colored composition, typically comprising a thermoplastic resin and a pigment, is applied to the surface of the forming grid in any convenient manner, for example, by spraying, brushing, or roller coating onto the surface of the grid a solution or dispersion of the composition in a volatile medium, usually an organic solvent medium. Any appropriate conventional solvent or mixtures of solvents may be used, such as hydrocarbon solvents (e.g. hexane, benzene toulene), ketone solvents (e.g. methyl ethyl ketone), chlorinated solvents (carbon tetrachloride), ethers (e.g., ethyl ether), esters (e.g. butyl acetate), etc. After application of the coating, the volatile solvent is evaporated (conveniently with the aid of forced air and/or heat if desired) leaving an essentially dry, solid, colored resinous film on the forming surface. Alternatively, a melt coating of the pigmented resin composition may be applied to the surface of the forming grid. It will be understood that the colored resinous coating is provided on the outer surface of the forming member only, that is, the surface of the forming member which corresponds to what will be the recessed surfaces of the vacuum formed plastic sheet. The recesses of the forming member (corresponding to what will be the elevations or raised portions of the vacuum formed sheet) are left bare or uncoated with the colored resin composition. The resin coating may be described as separable or strippable in the sense that it is essentially non-adherent to the forming member.

When the heated plastic sheet is vacuum formed against the forming member selectively coated with the colored resinous composition on its raised surfaces as described, the plastic sheet adheres to the colored resinous deposit. The plastic sheet may be regarded as, in effect, heat welded to the colored resinous coating since the plastic sheet is in a soft, heated condition and some of this heat is transferred to the resinous coating so that the surface of the resinous coating becomes more or less merged with the surface of the plastic sheet. If desired the resin coating on the surface of the forming member may be preheated, for example, by exposure to radiant heaters such as infra red lamps, prior to disposing the plastic sheet over the forming member. In any event, the plastic sheet becomes integrally united to the colored resin coating or film so that when the assembly is cooled and the vacuum formed sheet is removed from the forming member the colored deposit remains adhered to the plastic sheet, and readily separates from the forming member to which it inherently has no strong tendency to stick. The colored resinous composition thus appears in the final sheet as a colored coating or design in the recesses or depressions of the relief pattern imparted by the vacuum forming operation. The colored design thus transfers to the desired portions of the relief configuration on the plastic sheet.

If the colored resinous coating composition is not inherently compatible with (that is, adherent to) the plastic sheet material, a suitable adhesive may be applied to the colored coating before the plastic sheet is vacuum formed thereon. Thus, for example, if a colored vinyl coating is used in conjunction with a sponge rubber rug underlay composition as the plastic sheet, a conventional vinyl-to-rubber cement may be applied to the colored vinyl coating before the operation of forming the sponge rubber sheet.

The plastic sheet material itself may be pigmented or colored, and may be opaque or translucent, but especially interesting effects may be obtained by using a transparent plastic sheet material, and coating the forming member with two successive layers, of different colors. In the finished article, the first color applied is visible from the front of the transparent sheet only, while the second color applied is visible through the back of the transparent sheet only.

While reference has been made particularly to colored coatings, it will be appreciated that desirable effects may also in some cases be obtained with unpigmented coatings, particularly when such unpigmented coatings are used for example for reinforcing, in conjunction with colored coatings if desired.

The method of the invention is useful for making printed circuits, that is, conductive materials such as metal powder may be added to the coating to make it conductive, while the plastic sheet serves as an insulating supporting base for the conductive network adhered thereto, represented by the conductive coating composition.

Interesting and useful effects may be obtained by using luminescent or reflective substances in the resin coating and/or in the

plastic sheet base. Metallized resin coatings and/or metallized plastic sheets also provide interesting and desirable effects.

Among the products that may be produced to advantage from embossed, printed sheets made by the present method may be mentioned sponge carpet, floor coverings of various kinds, upholstery materials, and the like, in addition to those mentioned previously.

Referring to the drawing, the particular embodiment of the invention represented therein has to do with simultaneously forming and decorating a transparent plastic sheet 10. The plastic sheet is formed in an embossed or relief design represented by decorative protrusions 11 extending upwardly or outwardly from the face of the sheet. Areas 12 of the sheet between the protrusions 11 represent relatively inwardly depressed or recessed portions, in relation to the protrusions. A resinous coating layer 13 of a certain colour covers such recessed areas and is visible from the front or upper surface of the sheet. A differently colored resinous coating layer 14 underlies the first outer resinous coating layer and is visible through the back or underside of the transparent plastic sheet. The sheet thus presents contrasting appearances from its front and rear faces.

The sheet is shaped and provided with the described colored design with the aid of a grill or shaping member 17 which is nothing more than a sheet metal plate (e.g. aluminum or steel 1/16 inch thick) perforated with holes 18 having the outline of the protrusions 11 desired in the plastic sheet.

A coloured resinous coating composition is made up, for application to the upper or front surface of the forming grid 17, for example according to the following formulation:

Ingredient	Parts by Weight
(a) Vinyl chloride/vinyl acetate copolymer (90/10)	100
(b) Polymethyl methacrylate (a 40% solution of resin in methyl ethyl ketone solvent)	14 dry (weight)
(c) Silicone oil ("DC-200"-dimethyl silicone having a viscosity of 100 centistokes)	3.3
(d) Dioctyl phthalate	29
(e) Pigment (color optional, e.g. red)	125
(f) Methyl ethyl ketone present as solvent in item (b)	21

The above ingredients are dissolved in the following solvent solution:

(g) Acetone - - 1300 parts by weight
(h) Cyclohexanone - 660 " " "
Total solids 12%

This coating is sprayed onto the upper surface of the grid 17. It should be recognized that the percentage of solids in the coating can be adjusted to conform to the method of application and the thickness of the coating desired. If the coating is applied by rollers the viscosity of the coating solution can be adjusted by changing the percentage of solids or by adding thickening agents. The coating solution is allowed to dry on the grid surface either at room temperature or under forced drying conditions. The thickness of the coating remaining on the grid is dependent on the end effect desired and varies with the pigment level. In this example, the first dried colored resin coating 13 (Fig. 5) has a thickness of 2 mils. This coating operation is repeated, using the second time a coating solution containing a differently colored pigment, for example a yellow pigment in place of the red pigment used in the first coating. The results in deposition of a second differently coloured resin coating 14 (Fig. 6) on top of the first resin coating 13.

The plastic sheet 10 to be formed is initially provided in the form of a flat sheet as shown in Fig. 7, and it has for example the composition disclosed in Example I of U. S. Patent 3,018,268, Daly, Jan. 23, 1962. The composition is calendered at 300—320°F. into a sheet 10 having a thickness of 10 mils. The sheet is clamped in a peripheral supporting frame 20 (Fig. 7) as is usual in vacuum forming operations and it is heated by conventional radiant heaters such as infra red lamps (not shown) to a temperature at which the sheet is soft and readily formable. Frequently this temperature is in the range from 300° to 360°F. (preferably about 330°F.).

The forming grid or plate 17 bearing the resin coatings 13, 14 facing upwardly is placed on top of a conventional vacuum table 25 (Fig. 8) which has holes 26 in its upper surface for application of vacuum. A screen 27 (e.g., ordinary insect screening) interposed between the top of the table 25 and the undersurface of the forming plate serves to insure communication of the vacuum with all of the perforations 18 of the forming plate. While the sheet 10 is in the described heated condition it is positioned on top of the resin-coated forming plate 17 as shown in Fig. 8

and vacuum is then applied, drawing the sheet into the perforations 18 of the forming plate as shown in Fig. 9, and at the same time pressing the intermediate surface areas 12 of the sheet into intimate contact with the upper surface of the second pigmented resin coating 14 on the upper surface of the forming plate. The shaping and laminating force is of course the atmospheric pressure to which the upper surface of the sheet is freely exposed. The hot plastic sheet thus becomes united to the resin coating (to which some of the heat of the sheet is transferred) and the assembly is allowed to cool in this condition to a temperature at which the sheet is sufficiently form-sustaining to be handled without distortion. The vacuum is then broken, releasing the formed sheet. The formed plastic sheet is removed from the vacuum table, and the forming plate 17 is stripped off. The coatings 13, 14 readily release from the forming plate, that is, the coatings stick to the surface 12 of the plastic sheet 10. Upon removal of the peripheral holding frame 20 the sheet has the appearance shown in Figs. 1 and 2.

WHAT WE CLAIM IS:—

1. A method of making an article of a polymeric resin having co-ordinated surface relief and colouring; which method comprises applying a coloured material to a vacuum former having one or more depressions and/or apertures therein, the coloured material being adherent to the polymeric resin and strippable from the former and being applied to one or more surface areas of the former which do not constitute depressions, applying a sheet of the polymeric resin to the surface of the former, evacuating air from the space between the sheet and the former, releasing the vacuum, and stripping the formed sheet with the coloured material adhering thereto.

2. A method as claimed in Claim 1, wherein the polymeric resin is heated to a temperature at which it is plastic, before application to the forming member and is cooled while impressed on to the forming member.

3. A method as claimed in Claims 1 or 2 wherein the polymeric resin from which the article is to be made is translucent and two layers of colouring materials of different colours are applied to the forming member.

4. A method of making an article of a polymeric resin substantially as described with reference to the accompanying Drawings.

5. An article when made by a method as claimed in any one of the preceding Claims.

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Agent for the Applicants.

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1 SHEET This drawing is a reproduction of the Original on a reduced scale

FIG.1.

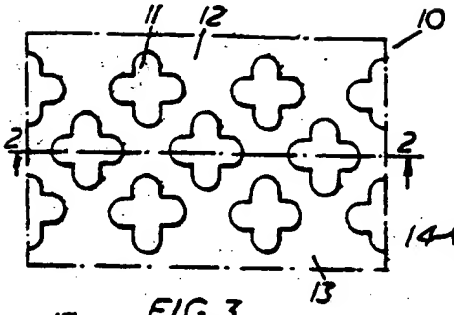

FIG.2.

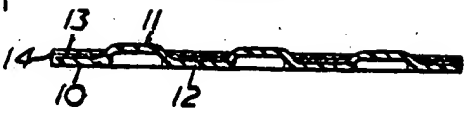

FIG.3.

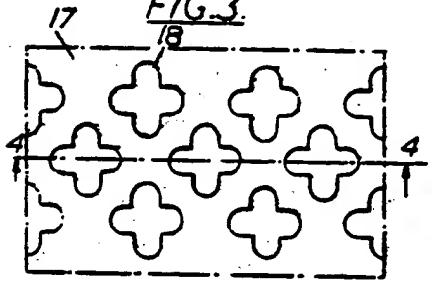

FIG.4.

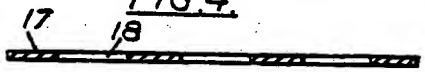

FIG.5.

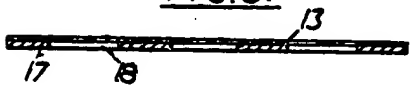

FIG.6.

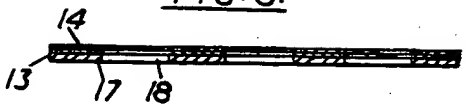

FIG.7.

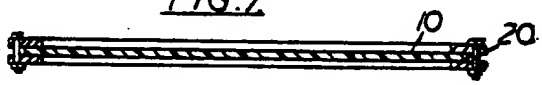

FIG.8.

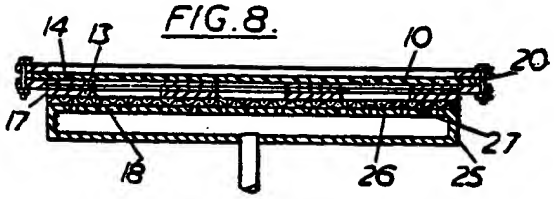

FIG.9.